

DEVELOPING FRESH MARKET TOMATO LINES BY SELECTION

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ABSTRACT

This investigating was carried out during the period from 2006 to 2009 in successive summer seasons at Kaha Horticultural Research Station, Kaluabla Governorate, Egypt, to study the genetic variability and heritability for some plant and fruit characteristics of tomato and develop new fresh market lines. Seven lines of tomato in F₆ selected from 3 F₂ generations of Rocky, Dora and Petopride²were used in this study. After seven generations of selection the estimated coefficient of variance (C.V%) values, varied from trait to another, while the selected genotypes became enough homogenous for number of days from transplanting to 25-50% flower anthesis, plant height, number of branches and fruit length and diameter and could therefore be considered as new lines. The results showed significant differences between the seven selected lines and check cultivars in both seasons in some studied traits, in the favor of new lines. The results revealed high values of genotypic coefficient of variation (GCV %) and heritability in broad -sense (H^2_{BS}) for all studied traits. The values of GCV % ranged from 6.64 to 30.3 %, for days to flowering and early yield/plants respectively, and H^2_{BS} ranged from 70 to 98 % for vitamin C content and days to flowering respectively, indicating that all traits were highly heritable and small environmental effects. It could be concluded that the lines G₂, G₅ and Z₃ are considered promising for releasing as new cultivars because they are homogeneous with high productivity and good fruit characters for fresh market purpose.

Key words: *Tomato lines, Homogeneity, Fruit characteristics, Component of variance, Coefficient of variation, Heritability.*

INTRODUCTION

Developing new locally produced tomato cultivars is one of the most important steps for improving tomato production. High yield components, fruit quality, earliness, growth habit, disease resistance and adaptation to environment are very important to make a successful cultivar for fresh market tomato. According by, investigators compared between hybrids and recombinant inbred lines for producing new varieties of tomatoes. Kansouh (2002) evaluated 24 promising F₆ lines and found that some selected lines surpassed the check cultivars for plant height and number of branches. Also he found that the homogeneity of plants within some selected lines in F₆ existed for plant height, fruit length, fruit diameter and total soluble solids (TSS).

As for earliness, Christakis and Fasoulos (2002) evaluated the response to selection, as percentage of the first segregating generation of three commercial hybrids. They found that many lines were earlier than

their F₁ hybrids. Concerning total yield, Salib (2006) evaluated fifteen promising lines in the F₆ generation. All lines significantly outyielded the highest check cvs. He concluded that, all these lines were comparatively superior to the check cvs and could be recommended as new lines for fresh market. Bhnar (2008) evaluated five selected lines in F₇ generation with three check cvs, and found that some lines were superior to the check cvs for plant height, number of main branches, early yield, total yield, fruit weight, fruit firmness, flesh thickness and TSS.

Hence, the objective of the present study was to evaluate some new promising tomato lines in F₈ generation for fresh market and select the best lines for most important plant and fruit characteristics.

MATERIALS AND METHODS

This study was carried out at Kaha Horticultural Research Station, Kaluabia Governorate, ARC, during the period from 2006 to 2009. Seven lines of tomato (*Lycopersicon esculentum* Mill) in F₆, selected from 3 F₂ generations of hybrids Rocky, Dora and Petopride2, (Zakher2005) were used in this study.

Seeds of seven selected lines were grown in 2006 and 2007 seasons to produce the F₇ and F₈ generation, respectively. The seven lines in F₈ and two check cultivars (Castle rock and Floradade) were evaluated in 2008 and 2009 seasons for some important characters. i.e. days from transplanting to flowering, plant height, number of branches, fruit length and diameter, to determine the degree of homogeneity in these genotypes via estimating coefficient of variation. The seedlings were transplanted on March 15 and 17 in 2008 and 2009 respectively.

A randomized complete blocks design with three replicates was used. Each plot consisted of two rows, each row was 1m width and 6 m length and seedlings were set 40 cm apart. Recommended cultural practices were followed. Ten plants per plot were randomly labeled in each plot and used record plant height (cm), number of branches and number of leaves per plant after 105 days from transplanting. Days from transplanting to flowering trait was measured as number of days from transplanting till 25 – 50 % flower anthesis per plot. Days from transplanting to ripening trait was measured as number of days from transplanting till 25 – 50% of fruit turning red maturity stage per plot. Early yield (kg/plant) was recorded as the yield of the first three pickings, and total yield per plant (Kg/plant) as total weight of all harvested fruits. Average fruit weight (gm) was determined by dividing total fruit weight on the total fruit number. A random sample of five fruits per plot was used for measuring fruit length, diameter and flesh thickness (by using a caliper) and number of locules. The measurements were recorded at the same stage from the harvesting in mid-season and the averages were calculated. Fruit firmness was measured using a needle type

pocket penetrometer. The percentage of total soluble solids (TSS %) in the fruit juice was determined by a hand refractometer. Ascorbic acid was determined by titration with 2,6 dichlorophenol – indophenol method as indicator (A.O.A.C 1990). Data were statistically analyzed and means were compared based on the L.S.D. test according to Snedecor and Cochran (1982). Component of variance, genotypic coefficient of variation and broad-sense heritability were estimated according to Singh and Chaudhary (1995).

RESULTS AND DISCUSSION

Degree of homogeneity

Estimates of coefficient of variation (C.V %) for days from transplanting to flowering, plant height, number of branches per plant, fruit length and fruit diameter are presented in Table (1).

For days from transplanting to flowering, C.V% ranged from 1.94 to 3.90% in the selected genotypes while they ranged from 3.93 to 4.03% in the check cultivars. However, in general all the selected genotypes showed C.V% values lower than those of the check cvs for days to flowering.

Table 1. Estimates of coefficient of variation (C.V. %) for five studied characters in the selected genotypes.

Genotypes	Days from transplanting to flowering	Plant height	Number of branches	Fruit length	Fruit diameter
G1	3.90	2.19	7.40	4.39	4.22
G2	3.58	4.88	6.43	2.87	3.54
G3	3.44	4.91	1.61	5.58	3.77
G4	1.94	4.21	7.10	5.26	5.40
G5	3.46	1.61	7.06	6.50	6.75
Z1	3.44	4.55	7.20	5.89	5.27
Z3	3.36	3.30	7.43	6.27	4.85
Check cvs. Castle rock	3.43	5.08	10.16	8.06	8.22
Floradade	3.93	5.88	7.45	6.51	6.90

For plant height, all selected seven genotypes could be considered homogeneous, since they gave the lowest variation (C.V% < 5.00%), while the C.V% values for those of the check cvs. were higher (C.V% > 5.00%).

Regarding number of branches per plant, the highest homogeneity was observed for plants of all new lines as compared to the check cultivars Castle rock and Floradade.

With respect of fruit diameter, obtained data (Table 1) the new genotypes showed less CV% values than those recorded by the check cultivars, indicating that these new genotypes became highly homogeneous in this trait.

In general, the degree of homogeneity varied from genotypes to another in the same character and from trait to another in the same genotype.

Nearly, all seven selected lines in F₈ became highly homogeneous compared with the check cultivars Castle rock and Floradade which are widely grown in Egypt.

Mean performance of the selected lines

Means of the evaluated breeding lines are presented in Tables (2, 3 and 4). Highly significant differences among the lines were observed for all studied traits.

Days from transplanting to flowering for the new lines ranged from 41.7 to 44.7 with a mean of 42.9 days in the first season and from 29.0 to 34.3 with a mean of 30.2 in the second season in lines G₁ and G₃ respectively.

Compared with two check cvs the selected seven lines significantly earlier than Floradade except one line (G₃).

Days from transplanting to ripening, ranged from 81.6 to 84.7 with a mean of 82.9 days and from 67.0 to 81.3 with a mean of 76.0 days in lines G₁ and G₃ in the seasons 2008 and 2009, respectively. In this respect, all seven lines significantly ripened earlier than the check cvs Floradada. On the other hand, the earliness of ripping was recorded in the lines G₁ and G₄ in both 2008 and 2009 seasons.

Plant height of the studied lines ranged from 64.3 to 83.0 with a mean of 71.5 cm and from 60.0 to 82.6 with a mean of 72.9 cm in lines Z₁ and G₂ in both 2008 and 2009 seasons, respectively. The two lines G₂ and G₅ showed maximum height (83.0 and 75.3 cm) in the first season, (82.6 and 79.3 cm) in the second season which significantly exceeded Floradade (the tallest check cultivar by (24.0 and 16.3%) and (27.3 and 24.3%) in 2008 and 2009, respectively.

Table2. Mean performance of the seven evaluated breeding lines in F₃ and two check cultivars for Days from transplanting to flowering and ripening and vegetative growth traits during summer seasons 2008 and 2009.

Genotypes	Days from transplanting to flowering		Days from transplanting to ripening		Plant height (cm)		Number of branches per / plant		Number of leaves per / plant	
	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009
G1	41.7	29.0	81.6	67.0	68.3	71.3	6.3	6.7	48.0	49.0
G2	42.7	31.0	82.6	78.0	83.0	82.6	7.3	7.3	60.6	60.6
G3	44.7	34.3	84.7	81.3	70.3	77.3	6.0	5.7	49.0	49.3
G4	42.3	29.6	82.3	68.3	70.3	76.3	6.6	6.7	46.6	49.0
G5	42.7	29.0	82.6	78.3	75.3	79.3	7.0	7.0	58.7	60.0
Z1	43.7	29.3	83.7	79.6	64.3	60.0	6.6	7.0	39.6	40.0
Z3	42.7	29.3	82.6	79.6	68.7	63.3	8.0	7.3	61.6	63.3
Mean	42.9	30.2	82.9	76.0	71.5	72.9	6.8	6.8	52.0	53.0
Check cvs.										
Castle rock	41.7	33.6	81.6	77.3	54.7	56.6	4.6	5.0	37.0	37.6
Flora Dade	45.0	33.3	86.6	85.3	63.0	60.0	6.3	6.7	43.0	43.3
L.S.D 5%	1.526	1.909	1.682	2.870	7.019	8.980	1.206	1.843	3.362	9.560
1%	2.103	2.631	2.317	3.954	9.670	12.372	1.662	2.539	4.632	13.10

Number of branches per plant, was the highest in line Z₃ (8.0 and 7.3) followed by line G₂ (7.3 and 7.3) and G₅ (7.0 and 7.0) in 2008 and 2009, respectively, without significant difference between them. In this respect, all seven selected lines gave high means as compared with check cvs Castle rock with significant differences in both seasons, except line G₃ in the second season which gave higher mean than Castle rock but without significant difference between them.

Number of leaves per plant, ranged from 39.6 to 61.6 with a mean of 52 in the first season, and from 40 to 63.3 with a mean of 53 in the second season. The three lines Z₃, G₂ and G₅ produced the highest number (61.6, 60.6 and 58.7) and (63.3, 60.6 and 60.0) in the 2008 and 2009, respectively and significantly exceeded Floradade (the highest check in this trait) by (30.1%, 29.0 and 26.7) and (32.7%, 29.7 and 29.0%) in the 2008 and 2009 seasons respectively.

In general, the new breeding lines G₂, G₃, G₅ and Z₃ showed vigorous growth, since they recorded high values for plant height, number

of branches and leaves per plant and may be used as materials for vigorous growth in hybridization programs. These results regarding the studied vegetative growth traits were in agreement with the previous studies of Kansouh (2002), Zakher (2005), Salib (2006) and Bhnan (2008) who found that some selected tomato lines surpassed the check cultivar in those of traits.

Average fruit weight ranged from 100.0 to 166.6 with a mean 122.3 g and from 86.6 to 116.6 with a mean of 86.7g in the 2008 and 2009, respectively (Table 3). The three lines G₅, G₂ and Z₃ showed maximum fruit weight (166.6, 133.3 and 126.6g) and (116.6, 110.0 and 106.6 g) in the 2008 and 2009, respectively, and significantly exceeded Castle rock (the highest checking fruit weight) by 42.0, 27.5 and 23.7%) and (22.8, 18.8 and 15.6%) in seasons 2008 and 2009, respectively.

Regarding fruit length, diameter, number of locules and flesh thickness, the obtained data (Table 3) showed significant differences among the lines studied. In 2008 and 2009 seasons the selected lines produced fruits ranging from (5.13 to 6.10 cm) and (from 5.06 to 5.60) in length, from (5.46 to 6.50 cm) and from (4.73 to 5.6 cm) in diameter, respectively. For the number of locules per fruit in the first season, the selected lines ranged from 2.63 to 4.63 in lines Z₃ and G₅, respectively. In the second season, the number ranged from 3.0 to 4.76 for lines Z₃ and G₂, respectively. Mean while, in both seasons 2008 and 2009, the check cultivars Castle rock and Floradade gave means (4.46 and 4.50) and (4.43 and 4.50) respectively for number of locules per fruit. Also the flesh thickness ranged from 0.423 to 0.653 cm in 2008 season and from 0.466 to 0.583 cm in the 2009 for lines Z₃ and G₄, respectively.

Fruit firmness of the lines Z₃, Z₁ and G₂ was the best and reached to (3.01, 2.60 and 2.50) and (2.80, 2.15 and 2.13) in the 2008 and 2009 seasons, respectively, compared with the check cultivars Castle rock and Floradade which gave values (2.70 and 2.23) and (2.80 and 2.15) in the 2008 and 2009 seasons, respectively.

These results were in coincidence with those of Kansouh (2002), Zanata (2002), Zakher (2005) who found significant differences among lines and studied cultivars for average fruit weight, length and diameter, number of locules and firmness.

For early yield, the new lines produced early yield ranging from 0.847 to 1.217 with a mean of 1.071 Kg/plant and from 1.109 to 1.419 with a mean of 1.258 kg/plant in 2008 and 2009, respectively (Table 4).

Table3. Mean performance of the seven evaluated breeding lines in F₈ and two check cultivars for fruit physical characters during summer seasons 2008 and 2009.

Genotypes	Average fruit weight (g)		Fruit length (cm)		Fruit diameter (cm)		Fruit firmness (kg/cm ²)		Number of locules		Flesh thickness (cm)	
	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009	2008	2009
G1	100.0	93.3	5.13	5.10	5.86	5.56	2.33	2.05	4.03	3.93	0.490	0.493
G2	133.3	110.0	5.40	5.06	6.03	5.53	2.50	2.13	4.30	4.76	0.470	0.470
G3	113.3	93.3	5.16	5.20	5.66	5.60	2.26	2.00	4.23	3.83	0.493	0.483
G4	100.0	86.6	5.23	5.33	5.53	5.60	2.35	2.12	3.83	3.63	0.423	0.466
G5	166.6	116.6	5.36	5.06	6.50	5.60	2.40	2.12	4.63	4.56	0.480	0.473
Z1	116.6	100.0	5.40	5.06	5.73	5.60	2.60	2.15	3.80	3.63	0.466	0.480
Z3	126.6	106.6	6.10	5.60	5.46	4.73	3.01	2.80	2.63	3.00	0.653	0.583
Mean	122.3	86.7	5.39	5.20	5.82	5.46	2.49	2.19	3.92	3.90	0.496	0.493
Check cvs												
Castle rock	96.6	90.0	5.76	5.43	5.43	5.70	2.70	2.80	4.46	4.43	0.530	0.550
Floradade	93.3	86.6	5.03	4.66	5.33	5.16	2.23	2.15	4.50	4.50	0.426	0.426
L.S.D 5%	17.50	14.66	0.523	0.371	0.300	0.554	0.297	0.265	0.729	0.703	0.084	0.066
1%	24.12	20.20	0.721	0.511	0.413	0.764	0.410	0.360	1.004	0.968	0.116	0.091

All lines selected produced early yield more than 1.00 kg/plant in both seasons except lines G₃, G₅ and Z₁ in the first season only which produced 0.847, 0.981 and 0.944 kg/plant, respectively. However, compared with the two check cultivars, all the selected seven lines, produced earlier yield than that recorded for the check cultivar Castle rock (the highest check) except line G₃ in the first season only. Similar results were recorded by Christakis and Fasoulas (2002), Zakher (2005) and Bhanan (2008) who found that some tomato lines were earlier than the check cultivar.

Significant differences between the evaluated breeding lines were observed in the total yield (Table 4), since their yields ranged from 1.650 to 2.290 with a mean 1.989 Kg/plant and from 2.133 to 2.540 with a mean 2.386 kg/plant in 2008 and 2009 seasons, respectively.

Table4. Mean performance of the seven evaluated breeding lines in F₈ and two check cultivars for yield components and fruit chemical characters during summer seasons 2008 and 2009.

Genotypes	Early yield/plant (kg)		Total yield/plant (kg)		T.S.S. (%)		Vitamin C content (mg/100g)	
	2008	2009	2008	2009	2008	2009	2008	2009
G1	1.235	1.419	1.955	2.337	3.76	5.23	24.49	26.30
G2	1.162	1.297	2.148	2.485	4.53	5.70	20.57	21.34
G3	0.847	1.271	1.650	2.395	4.06	5.43	21.97	24.62
G4	1.112	1.235	1.826	2.133	3.76	5.50	21.68	22.85
G5	0.981	1.170	2.116	2.475	4.16	5.66	23.45	25.04
Z1	0.944	1.109	1.938	2.340	4.16	5.40	27.34	28.29
Z3	1.217	1.311	2.290	2.540	4.56	6.60	25.08	28.15
Mean	1.071	1.258	1.989	2.386	4.14	5.65	23.51	25.23
Check cvs. Castle rock	.941	.926	1.691	1.808	4.26	6.43	23.45	23.60
Floradade	.706	.686	1.285	1.316	5.40	6.33	26.55	26.39
L.S.D 5%	0.247	0.252	0.230	0.330	0.708	0.536	3.196	3.851
1%	0.340	0.347	0.317	0.455	0.976	0.739	4.404	5.315

In both seasons, the highest total yield per plant was produced by line Z₃ followed by lines G₂ and G₅. All breeding lines significantly outyielded the check cultivar. Moreover, the percentage increase in total yield was 26.2 and 27.2% in line Z₃ in both seasons compared with the high check cultivar (Castle rock). It could be concluded that all these lines are superior comparatively to the check cvs and could be recommended as new lines. These results apparently, confirmed those reported by Mochizuki *et al* (1988), Zakher (2005), Salib (2006) and Bhnan (2008).

Total soluble solids values in tomato fruits of breeding lines ranged from 3.76 to 4.56 with a mean of 4.14% and from 5.23 to 6.60 with a mean of 5.65% in 2008 and 2009, respectively (Table 4).

Compared with the two check cultivar, the selected seven lines, did not significant differences in both seasons except lines, G₁ and G₄ in the first season where, the differences between them were significant. These

results are in agreement with those of Mohamed and Hewedy (1994) and Kansouh (2002).

The breeding lines contained ascorbic acid content in their fruits ranging from 20.57 to 27.34 with a mean of 23.51 mg/100g, fresh weight of fruits from 21.34 to 28.29 with a mean of 25.23 mg/100g, in 2008 and 2009, respectively. The highest values of vitamin C content (27.34, 25.08 and 24.49) and (28.29, 28.15 and 26.30 mg/100g fruit) in 2008 and 2009 seasons respectively, were reflected by the lines Z₁, Z₃ and G₁. Mean while, the lowest content of vitamin C was given by line G₂, since it showed 20.57 and 21.34 mg/100g fruits in both seasons, respectively.

Components of variance

Estimates of components of variance, genotypic coefficient of variation and broad sense heritability for the studied traits were listed in Table (5). Estimated broad – sense heritability (H^2_{BS}) ranged from 70 to 97 % for vitamin C content and days to flowering respectively.

The estimated genotypic coefficient of variation (GCV%) for the studied traits were 6.64 and 13.1 % for days from transplanting to flowering and ripening respectively, 30.3 % for early yield, 30.1% for total yield, 13.4% for plant height, 22.2 % for number of branches, 17.0 % for average fruit weight 8.10 % for fruit length, 10.6 % for fruit diameter, 14.2 % for total soluble solids content, 13.5 for vitamin C content. These results of genotypic coefficient of variation as well as broad-sense heritability indicated a small environmental effect and large genetic component in comparison to the phenotypic variation. Therefore, these characters can be improved through selection based on phenotypic observations.

In particular the lines G₂, G₅ and Z₃ could be considered promising lines for releasing new cultivars because they are homogeneous with high productivity and good fruit characters for fresh market.

Table 5. Components of variance (σ^2_g and σ^2_p), genotypic coefficient of variation (G.C.V %) and broad sense heritability (H^2_{BS}) for studied traits.

Components	Days from transplanting to flowering	Days from transplanting to rippling	Early yield/plant.	Total yield/plant	plant height	Number of branches	Average fruit weight	Fruit length	Fruit diameter	T.S.S.	Vitamin C content
σ^2_e	1.22	2.75	0.02	0.04	24.26	0.49	71.8	0.042	0.03	0.096	4.97
σ^2_g	4.62	102.25	0.124	0.44	87.47	2.09	279.1	0.173	0.37	0.676	11.6
σ^2_p	5.84	105.10	0.144	0.48	111.73	2.58	350.9	0.215	0.40	0.772	16.57
H^2_{BS}	79	97	86	92	78	81	80	81	93	88	70
G.C.V%	6.64	13.1	30.3	30.1	13.4	22.2	17.0	8.10	10.6	14.2	13.5

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استنباط سلالات من الطماطم للاستهلاك الطازج

بواسطة الانتخاب

الفونس جريس زاخر

قسم بحوث الخضار - معهد بحوث البساتين - مركز البحوث الزراعية - الجيزة

أجريت هذه الدراسة بمزرعة محطة بحوث البساتين بقها - محافظة القليوبية خلال الفترة من عام ٢٠٠٦ إلى ٢٠٠٩ فى مواسم صيفية متتالية بغرض تقييم التباين الوراثى وكفاءة التوريث لبعض الصفات النباتية والثمرية لاستنباط سلالات جديدة بغرض الاستهلاك الطازج. سبعة سلالات منتخبة فى الجيل الثامن تم الحصول عليها من خلال برنامج للتربية ابتداء ببنور ثلاث عشائر للجيل الثانى لثلاث هجن جيل أول هى (روكى و دورا وبيتوبريد ٢) وإدخالها فى برنامج للانتخاب مع تسجيل النسب حتى الجيل الثامن حيث أجرى الانتخاب بين وداخل السلالات لأحسن النباتات وفى كل مرة يتم جمع البذور الناتجة من كل نبات على حدة. بعد سبعة أجيال من الانتخاب اختلف معامل الاختلاف من صفة الى لأخرى بينما كانت السلالات السبعة فى الجيل الثامن عالية التجانس للصفات (عدد الأيام من الشتل الى إزهار ٢٥-٥٠% من النباتات وارتفاع النبات وعدد الأفرع وطول وقطر الثمرة) مما يمكننا من اعتبارها سلالات جديدة.

أظهرت الدراسة وجود فروق معنوية بين السلالات السبعة المنتخبة وبين صنفى المقارنة كاسل روك وفلورانيت فى بعض الصفات المدروسة فى كلا الموسمين. أظهرت النتائج أيضاً قيم عالية لمعامل الاختلاف الوراثى وكذلك كفاءة التوريث فى كل الصفات المدروسة حيث كانت قيم معامل الاختلاف الراجع إلى التباين الوراثى تتراوح من ٦.٦٤ إلى ٣٠.٣% لصفة عدد الايام من الشتل للازهار و صفة المحصول المبكر على التوالي وقيم كفاءة التوريث فى معناها الواسع تتراوح من ٧٠ إلى ٩٧% لصفة محتوى الثمار من فيتامين ج وصفة عدد الايام من الشتل النضج على التوالي مما يدل على ان كفاءة التوريث عالية وتأثير البيئة على الصفات صغير.

ومن بين السلالات السبعة فإن السلالات G_2 ، G_5 ، Z_3 يمكن الاعتماد عليها فى الإنتاج التجارى مباشرة كأصناف تجارية أو كمواد وراثية فى برامج التربية لإنتاج هجن محلية متميزة فى صفات الجودة والمحصول و صفات النمو الخضري بغرض الاستهلاك الطازج.

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